Claims

1. Heat exchange and/or chemical reactor apparatus (10; 100) comprising a series of plates which are stacked and bonded together in a fluid-tight manner, the series of plates comprising alternate first (30; 130) and second (90; 190) plates or groups of plates along the stack providing flow paths for respective first and second fluids, each plate forming said first (30; 130) and second (90; 190) plates or groups of plates having an inlet (42, 90; 138, 195) and an outlet (43, 91; 139, 196) between which respective first or second fluid is flowable and a continuous wall (34, 84; 134, 194) to contain the flow of fluid, and characterised in that each plate (30, 90; 130; 190) comprises an outer wall (43, 83; 133, 197) at least partially encompassing the continuous wall (34, 84; 134, 194) to define a space (35, 85; 135, 195) therebetween, the spaces (35, 85; 135, 195) of each plate (30, 90; 130; 190) of the stack being in fluid communication to form a compartment running along the stack.

2. Apparatus (10; 100) according to Claim 1, wherein each continuous (34, 84; 134, 194) wall comprises integral, outwardly extending loops (38, 39, 90, 91; 138, 139, 191, 192), the loops (38, 39, 90, 91; 138, 139, 191, 192) being stacked together to provide inlet and outlet reservoirs for first and second fluids (16-19; 140, 150, 160, 170), the respective reservoirs communicating with the flow paths of the groups of plates via the inlet and the outlet for the respective fluids into and out of their respective groups of plates.

3. Apparatus (10; 100) according to Claim 2, wherein the outwardly extending loops (38, 39; 138, 139) of the first plate or stack of plates (30, 130) provide the inlet (42) and outlet (43) for the first fluid.

4. Apparatus (10; 100) according to Claim 2 or 3, wherein the outwardly extending loops (90, 91; 191, 192) of the second plate or stack of plates (90, 190) provide the inlet and out for the second fluid.

5. Apparatus (10; 100) according to any preceding Claim, wherein the alternate first (30; 130) and second (90; 190) plate or group of plates are separated by a single intervening plate or intervening group of plates (60; 161-163).

6. Apparatus (10; 100) according to Claim 5, wherein the first (30; 130) and second (90; 190) plates or groups of plates are separated by an intervening group of plates which comprise a sandwich of single intervening plate – one or more interlayer plates – single intervening plate (60; 161-163).

7. Apparatus (10; 100) according to Claim 6, wherein the or each interlayer plate (60; 162) comprises an interlayer first wall (64; 364) and a continuous outer wall (63; 363) encompassing the first wall (64; 364) to define an interlayer space (65; 365) therebetween, the region defined by the first wall (64; 364) being in fluid communication with said interlayer space (65; 365).

8. Apparatus (10; 100) according to Claim 7, wherein the interlayer first wall (34; 364) comprises one or more vents (67, 67A; 370) extending through, say, half the

thickness of the interlayer plate (60; 162) to provide fluid communication between the interlayer space (65; 365) and the region defined by the first wall (64; 364).

9. Apparatus (10; 100) according to Claim 7 or 8, wherein the interlayer space (65; 365) comprises part of the compartment in the stack of plates, which compartment, consequently, being in fluid communication with the region defined by the first wall (64; 364) of the interlayer plate (60; 162).

10. Apparatus (10; 100) according to any of Claims 5 to 9, wherein the or each single intervening plate (161, 163) has a solid portion (262; 462) to prevent fluid communication between said first (30; 130) and second (90; 190) groups of plates or between said first or second group of plates and the or each interlayer plate.

11. Apparatus (10; 100) according to Claim 10, wherein the single intervening plate (161, 163) comprises an outer wall (266, 466) encompassing and joined to its solid periphery (262, 462), a space (265, 465) being defined between the outer wall (266, 466) and the solid periphery (262, 462) which, in the stack of plates, communicates with the spaces (35, 85; 135, 195) of the plates of the first and second groups of plates, and interlayer plate if present, to comprise a portion of said compartment.

12. Apparatus (10; 100) according to any preceding Claim, wherein said compartment is sealed at either end of the apparatus.

13. Apparatus (10; 100) according to any preceding Claim, wherein said compartment is in operative communication with detection means, said detection means being

operable to detect the presence of either or both of said first and second fluids in said compartment.

14. Apparatus (10; 100) according to Claim 13, wherein said detection means may be selected from one or more of pressure sensors, such as valves or pressure transducers or devices which can directly detect or indicate the presence of leaking fluids such as spectrometers, spectrographs.

15. Apparatus (10; 100) according to any preceding Claim, wherein, in normal operation, the compartment is maintained at a pressure less than that experienced by the first and/or second fluids in the apparatus.

16. Apparatus (10) according to any preceding Claim, wherein each plate of the stack comprises a centrally disposed hole (31, 61, 91) defined by a surround (32, 62, 92), the aligned holes forming a bore (13) through the stack.

17. Apparatus (10) according to Claim 16, wherein the surround (32) or surrounds of a first plate or group of plates (30) adjacent one end of the stack have one or more apertures (49) leading into the central bore (13).

18. Apparatus (10) according to Claim 17, wherein the bore (13) contains a movable valve member (188) which in a first position prevents flow through the bore (13) and in a second position provides a fluid bypass route through the bore (13).

19. Apparatus (10) according to Claim 18, wherein the movable valve member (188) has a stem (187) and valve seat, the latter co-operating with a corresponding seat (185) defined in the central bore (13).

20. Apparatus (10) according to Claim 18 or 19, wherein operation of the bypass valve is temperature and/or pressure controlled.

21. Apparatus (10; 100) according to any preceding Claim, wherein the first plate or groups of plates and/or the second plate or group of plates, in the flow path between the inlet and outlet thereof, contains column precursors (50) and ligaments (51).

22. Apparatus (10; 100) according Claim 21, comprising first and/or second groups of plates wherein the column precursors (50) of adjacent plates (30A, B, C, D) in a group stack together to form the column (52) and ligaments (51) of each plate of the group are displaced relative to those of adjacent plate(s) in the group whereby, in use, fluid flowing across the group is not only forced to follow a tortuous flow path around the columns (52) but also over and under each ligament (51).

23. Apparatus (10) according to Claim 22, wherein the column precursors (50) are arranged in sectors, each sector separated from the next by a barrier (46, 47) of thickness (height) equal to the plate thickness.

24. Apparatus (10) according to Claim 23, wherein alternate barriers (46, 47) extend one from the outer peripheral edge of its plate towards but not reaching the centre (46), and the next from or towards the centre towards but not reaching the outer peripheral edge (47).

25. Apparatus (10; 100) according to any of Claims 1 to 20, comprising first and second groups of plates, the first and/or second groups of plates comprising a group of main perforated plates, wherein at least two adjacent plates of the group of main perforated plates have their perforations aligned in rows with continuous ribs between adjacent rows and the adjacent plates are aligned whereby the rows of perforations in one plate overlap in the direction of the rows with the rows of perforations of an adjacent plate and the ribs of adjacent plates lie in correspondence with each other to provide discrete fluid channels extending across the plates, a channel corresponding to each row of perforations, the channels together forming one or more fluid passageways across the plates and the passageway(s).

26. An aircraft comprising apparatus (10) according to any preceding Claim used to cool lubricating oil with fuel, the first fluid being oil, the second fluid being fuel.

27. An aircraft comprising apparatus (100) according to any of Claims 1 to 15 used to heat fuel with heated air, the first fluid being fuel the second fluid being air.

28. Apparatus (10; 100) according to any of Claims 1 to 25, comprising one or more flow paths for subsidiary fluids, the apparatus comprising means arranged to inject said subsidiary fluids into the flow of the one or both of said first and second fluids.

29. Apparatus (10; 100) according to Claim 28, comprising a third plate or group of plates for a subsidiary fluid, an intervening plate being present between said third plate or group of plates and one or both of said first and second plate or groups of plates, the

intervening plate having holes through its thickness to allow said third fluid to be injected into the flow of said first and/or second fluid.